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*Wojciech Kędzia**

FEASIBILITY AND PROFITABILITY STUDIES IN MINING INVESTMENT

The paper discusses the policies in copper mining using the example of the KGHM Polska Miedź S.A. against the world-wide trends and policies. The author stresses the importance of feasibility and profitability studies for the successful development of the Polish copper mining business.

1. INTRODUCTION

All resources are not renewable. Copper deposits in Polish copperfields have been exploited for 40 years. Annually about 30 million tons of ore are extracted. Possibilities of extractions in optimistic variant predict approximately 20 to 25 years. Within 5 to 10 years KGHM had not intended to develop its own mines, because copper ore between Polkowice and Głogów is situated in depths of below 1100 m. This situation causes a significant increase in costs and a lot of different problems connected with mining technology (ventilation, exploitation, etc). KGHM, like most mineral consortiums, does not want to lose its capital values so it has to try to replenish its own resources. If the KGHM Polska Miedź SA copper complex wants to continue its basic activity the company has to run its foreign research ahead, because natural resources in Poland are calculated to run short soon. These resources are situated beyond the Polish borders and create a chance for a not too expensive and profitable mine.

Nowadays foreign natural resources, possible for exploitation, occur in places where economic and political situation is not normalized. In spite of these threats world-wide mining companies invest capital expecting large profits. Investors, who took risk by investing in the mining industry 20 years ago in Chile, today significantly derive from its benefits. Taking

* ZG Rudna, KGHM PM S.A., Polkowice.

regional investments, South America continued to forge a commanding lead fuelled by the billion-dollar-plus copper project in Chile and Peru and accounting for more than 39% of global investment activity both in exploitation and milling. If we compare other countries the divisions are (Fig.1, Fig2): Asia (21.4%), Australia & Oceania (15.2%), and North & Central America (12.6%) followed by Africa (9%) and Europe (2.7%) (www.e-mj.com, www. infomine. com)

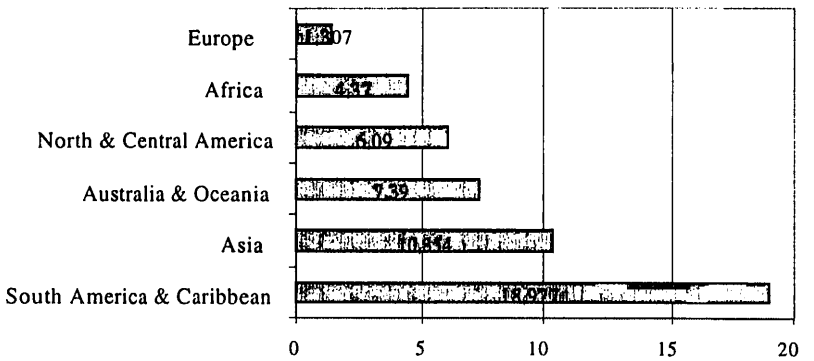

Fig. 1. Global mining investment by region (millions of dollars).
Source: *Engineering and Mining Project Survey*. Engineering & Mining Journal. 1998. Chicago.

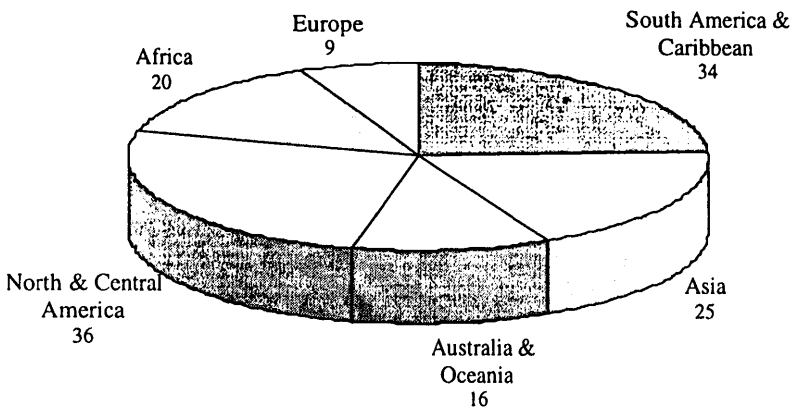

Fig. 2. Number of reported projects by region.
Source: *Engineering and Mining Project Survey*. Engineering & Mining Journal. 1998. Chicago.

Well-known and supplied documentary evidence about metal deposits in South America was bought in the past and developed by competitors. From that point we can only consider a possibility of creating joint ventures but costs of these enterprises would be counted in hundreds millions of dollars. This solution can be dropped. So finally we can concentrate on Central Africa (regions in Congo and Zambia to be precise) abounding in very attractive deposits of non-ferrous metals. All the important consortiums in the world have already been in this region for a long time. Companies who want to lead the mining world have all tried to enter these places. The first time KGHM took an interest in Africa's deposits was in 1996. A geological plan, which we obtained from the Gegamines consortium showed that it is worth investing in Africa for two reasons:

- there are a lot of interesting non-ferrous deposits,
- we can extract these deposits at a relatively small cost and make profitable enterprise.

These facts made KGHM start investing in Congo. We calculated that the mineral exploitation would take less than 13 months and bring in from $20 million to $200 million profit. Three years later KGHM extracted (all deposits were calculated for 605 thousand tons of ore) only 180 thousand tons, whereas we could process 15 thousand tons. The rest caused the forming of a big dump and nobody knows how to solve this problem. Finally in the last months of 1999 the mining investment was suspended which brought more or less $40 million of losses so far. There are some questions: What really happened? Why should we pay so high a price to learn the art of investing abroad? Could we avoid mistakes?

My purpose is to show how we should proceed in the proper estimation of investment project in the mining trade and how to avoid mistakes in the future. KGHM plans to invest further in non-ferrous deposits in Cuba, China, Canada and South America. I want to address my paper to all Polish mining consortiums who are going to invest in mines outside Poland. I describe the requirements which have to be met in a feasibility study, banking interests and profitability study to be able to admit the project as profitable and worth realizing.

A decision-maker in the mineral industry will probably make more difficult and important decisions than those in any other industry. The main reasons for this are (Nilsson 1996):

- the mineral industry is more capital intensive than most other industries,
- higher investments are required,
- the time needed to get production started and take profits is often longer than in other industries,
- capital costs, interest costs and other fixed costs are therefore high in the percentage of total costs,
- there are many uncertain factors about the future, such as the real ore grade in the deposit, changes in the direction of metal-prices etc.

The key to proper estimations of the project and making a good investment decision is a correctly executed feasibility study. The feasibility study is a document which satisfactorily provides all the information and audit necessary for the decision maker and his engineers who determine that the risks are acceptable and the project is provided on a stand-alone, project-finance basis. This document defines the project and consequently facilitates its financing. The aim of a feasibility study in the mineral industry is to describe the consequences of different options, find the best of them, describe the feasibility, profitability and other consequences of choice in detail. It also presents strong recommendation for the decision. In a feasibility study, a lot of information and data must be collected and compared. It answers all the questions a decision-maker might ask. This way we can avoid confronting unanticipated pitfalls (Ikoku 1985).

2. REQUIREMENTS FOR A FEASIBILITY STUDY

In many cases, the decision-maker does not know if the result of a study, and the decision based upon the study, is right or not (Newendorp 1975). This occurs in the future, when the construction of the plant is completed and the revenues have started to come in. The quality of results of a feasibility study and the degree of its certainty depends on the quality information one collects and compares, or in other words how much time

one spends on the study. In addition to these requirements different industry subsectors require individual consideration.

Clearly, ore reserves and geology are the most important subjects which should be taken into consideration in a feasibility study. The firm preparing the feasibility study should either reserve estimation expertise in-house or incorporate the work of a well-regarded specialist. Detailed descriptions of the estimation work, methodology, confidence, and breakdown of reserve categories are essential to the board of directors of a mining company, who understand the project's principal risk.

In general there are eleven categories of information that must be addressed in any feasibility study and posed some of the many specific questions that the study must answer.

2.1. Project background and ownership

Where is the project located? What is the topography? What is the climate? Is it a joint venture, a lease agreement, a land concession? Who owns the mineral rights? Who owns the water rights? Who gets paid a royalty?

2.2. Geology

Does the study include a reasonable analysis of the regional and local geologic setting? Does it include geologic maps and cross-sections? Does it include drilling, sampling, and assessing data and procedures for assuring the validity of this data? Does it describe the mineralogy and ore controls? (Harris 1984)

2.3. Ore reserves

The most common reason for project failure is lack of reserves. Examples of what should be done to find the ore reserves are:

- optimizing the ultimate depth of open pits,
- determining cut-off grades to find out which parts are worth mining,
- determining possible ore recoveries in those parts we have found worth mining,
- finding out whether all smaller parts are worth mining.

Key aspects of ore reserve reporting include model construction, lithology, composting, data analysis and statistics, variography, interpolation, recovery and dilution factors, and reserve estimates.

When the ore reserve is known, one has to determine the annual production rate. Factors to take into account are: the market, the size of the ore reserve, capacity restrictions, investment requirement in mine, plants, infrastructure, manpower requirement and availability, costs and revenues.

2.4. Reconciliation

What provisions are made for depletion, use of blasthole data, stockpile accounting, sampling, production history, and metallurgical accounting?

2.5. Mining

What is the mine plan? Have hydrology and geotechnical problems been addressed? What is the mining method?

The mining method must be determined. Factors to consider are: rock conditions, the depth, size and shape of the orebody, ore recoveries, costs and revenues. Then the haulage and hoisting method must be determined too. Alternatives are trucks, trains, conveyors, skiphoisting etc. Next the mine layout must be optimized. Examples of studies to be done are: optimal depth for location of a haulage system, optimization of the number of orepasses etc. Location of hoisting shafts, processing plants etc must be studied in order to minimize the costs (Megill 1971).

Finally we must consider if the study includes a mine equipment list, a mine development program, and production scheduling? Is there adequate provision made for stockpiling? Do consumables receive appropriate attention?

2.6. Processing and metallurgy

Is the metallurgical test work convincing? Is there a site plan? What are the milling methods and parameters? Is there a mill equipment list? Is there a flow-sheet? Are material balances included? What is the sampling protocol? Do consumables receive appropriate attention? How will tailings be handled?

Ore processing must be studied to find the best method and to find how much should be done within the company and how much should be left for the customer. For example: shall a metal concentrate be sold as it is or shall smelting and refining to refined metal also be done within the same company?

2.7. Infrastructure and support services

Does the study include a facilities list? How will the project be supplied with water, power, and fuel? What provisions are made for laboratories, for maintenance, for transport systems, for administrative support, for social programs?

From time to time we must consider the use of contractors and leased equipment as a final alternative, which can be used to reduce the investment and the size of our own workforce.

2.8. Environmental baselines and permits

What environmental statutes apply? Does the study address mining permits, and compliance procedures? Are provisions made for waste handling, rehabilitation, reclamation, and closure?

2.9. Development schedule

The development schedule is crucial while determining cash flows. The study must include a construction schedule, critical path items, a mobilization plan, and contracts.

2.10. Cost review

Does the study provide a detailed cost review, including operating costs, capital costs, contingency allowances, fees, taxes, and royalties? Does it make provision for inflation, and does it include appropriate sensitivities?

2.11. Management and personnel issues

Does the study set forth management qualifications? Does it detail operating procedures? Does it address labor force levels and collective agreements? Does it discuss contracting for drilling, mining, and transport?

Does it describe training and safety procedures? Does it outline reporting procedures?

3. BANKABLE FEASIBILITY STUDIES

The mineral industry requires a lot of money. A large mining company might finance a project on its own balance sheet, using corporate debt and equity. This situation allows for the fact that the total capital committed to the development of the project is at the risk of the corporation throughout the life of the mine. The transaction costs are lower, but cost of the capital may be higher owing to lower leverage. In many cases mining projects are financed by banks. This allows to reduce the risk connected with adversity of the project. Here both the bank and the mining company share the risk. Project financing transfers a significant portion of development capital risk to the project lenders. Transaction costs are higher, but higher leverage helps reduce the overall cost of capital.

Analysts follow a rather more traditional route when they determine the feasibility of proceeding with mine development. Once the exploration data are in, a reserve estimation is made, metallurgical test work is undertaken, and studies have the potential for development. A feasibility study is commissioned, a mining method is selected, and a process flowsheet is developed. Finally, cash-flow studies are run to fine-tune project financials and determine the payback period. This is a well-known procedure, but often it does not give all of the information a bank needs to determine whether a proposed mine project can be financed or not.

Economical and financial criteria described in a feasibility study may also influence a manager's decision to provide a mineral project or not. Among these criteria there are: target markets, return on capital, cross-border issues, portfolio restrictions, currency and exchange rate assumptions, tax regimes, dividend restrictions, funding effects on free cash flow and commodity price sensitivities (Walton 1992).

The feasibility study is the most credible description of the project and a definitive source of information. It must answer many questions and provide detailed descriptions and data to support the bank's or different lender's financial projections and analysis.

For the bank, a feasibility study must answer many questions (Dąbrowski 1992):

- do we want to do business on this property with this management team and this company?
- what are the risks, can they be mitigated and, if not, are they acceptable to the bank?
- does the transaction meet specific bank criteria such as company size, return targets, risk asset criteria, portfolio concentration by industry, and environmental and country risk?

And even if all of these questions are answered satisfactorily a bankable feasibility study might not receive financing. Additionally, it must have acceptable sponsors, meet internal bank criteria, and be marketable.

While a bank will not lend against a feasibility study, a bankable feasibility study is the foundation for any financing project (White 1998). It allows the bank to put some quantitative assessment on all of the critical elements of the project. It defines the reserve base and the method of calculation. It establishes the specific engineering and design parameters of the project. It provides a detailed estimation of the amount of investment required, including contingencies. It specifies the time periods for all life-of-project milestones. It identifies and quantifies critical risk areas. It confirms the economic viability of the project to investors and lenders.

The interests of lenders and investors are similar to those of the sponsors in that both groups willing to achieve a high degree of confidence in the key areas of their investment decision. However, the risk profile of the lenders does not typically include any of the project's upside potential, and, therefore, a feasibility study must include additional information on the downside risks (Kędzia 1999).

The banks or lenders need information similar to that required by the board of directors of a mining company. The biggest difference is that banks accept interest on the capital at risk, whereas the shareholders might not have been rewarded by the return. When things go well, the sponsoring company can achieve very high returns. The corollary is that most bank project financings entail reverse leverage. The bank has first call on cash flows for repayment of interest and principal before any distribution to the shareholders. If things are going wrong, there may be no return to

shareholders. The reward to capital-at-risk profile is very different for the bank and the mining company.

The major mineral companies always have access to capital to finance mining projects. The non-majors are more susceptible to changes in the market's degree of receptivity. As a consequence, medium- and junior-sized companies source their capital requirements where and how they can. The mining industry stands to benefit from the increased competition that is developing in the banking market. As is evident already, these benefits will manifest themselves in lower borrowing costs, longer terms, and less restrictive covenants. Nowadays a lot of capital is looking for a home. New players, such as finance companies, institutional investors, bullion and metal traders, and project equity groups, mean that the banks are no longer the exclusive source of debt financing. This situation means that the banks are increasingly willing to lend large amounts of capital to the mining industry and are also increasingly willing to venture further in the end, as is proven by recent financings of marginal projects.

For a number of reasons, project financing will continue to be a significant method of financing new mining projects. These reasons include increased investment in emerging markets and increased political risk; consolidation trends in the mining industry; longer construction periods for major mining projects, which increases the need for longer-term financings; growing capital requirements as well as an accompanying desire to manage risk positions; and a growing number of joint ventures that have multiple partners.

In project financing, the bank loan is primarily repaid out of cash flows from the project. Recourse is limited to such cash flows and to the project's assets. It does not refer to the other assets and the earning power of the company itself. The importance of bankable feasibility studies lies in the limited-recourse nature of project financing. Project cash flows are the sole source of repayment.

Next in importance are capital costs and cash flow. What is the total cost? How much accuracy can be ascribed to it? Is it based on firm quotes? Is there a contingency reserve for overruns — particularly relevant for projects located in awkward countries or remote sites? What is the economic return analysis for the sponsor's investment? Is allowance made for working capital, for the cost of arranging finance, for value added tax? Are infrastructure costs dealt with reasonably? Post-completion operating costs

and processing methodology are the next most important elements in evaluating a project. Operating costs plus other items in the life-of-mine plan are essential to the evaluation of project risks and economics. It is easy to estimate costs but the real problem in the mining industry is overruns. In part, there is a problem with engineering firms both doing the feasibility and constructing the project. It is a very competitive business. There is one main reason for the underestimation of the original capital cost - mistakes in estimation skills (Nickels 1987).

4. PROFITABILITY STUDIES

Management in the mineral industry must also consider the time value of money in their studies and therefore include a discount rate, which should be based upon (Łucki et al. 1990):

- the average cost for raising capital for the company from different sources, like loans, stocks, retained earnings etc,
- a risk factor,
- possible inflation and taxes.

The average cost for raising capital thus depends upon the capital structure of the company, how easy it is to get loans, what dividends the stockholders expect, the tax rules, etc.

In most real projects, the revenues are often the most important factors in the profitability study. They are also more difficult to forecast than investments and operating costs because incomes depend on metal prices, competition and the volatility of world-wide markets (Fig.3). Several months ago, the main factors driving the ongoing depression in world metals and minerals prices were:

- slowdowns in demand for metals and minerals among world countries,
- slowing growth in Asia and contractions in Japanese demand,
- uncertainty in Latin America,
- expansion of supply as significant mining projects around the world began production,
- better production technology.

For example: from more than 260 participants from 24 countries earnings from aluminium, gold, copper, lead, zinc, and nickel combined fell more than $18.6 billion last year. At this time losses in returns on shareholder funds ranged, for example, from 1.2 % in Australia to more than 9.9 % in Canada (www.e-mj.com; www.dolbear.com; www.jtboyd.com).

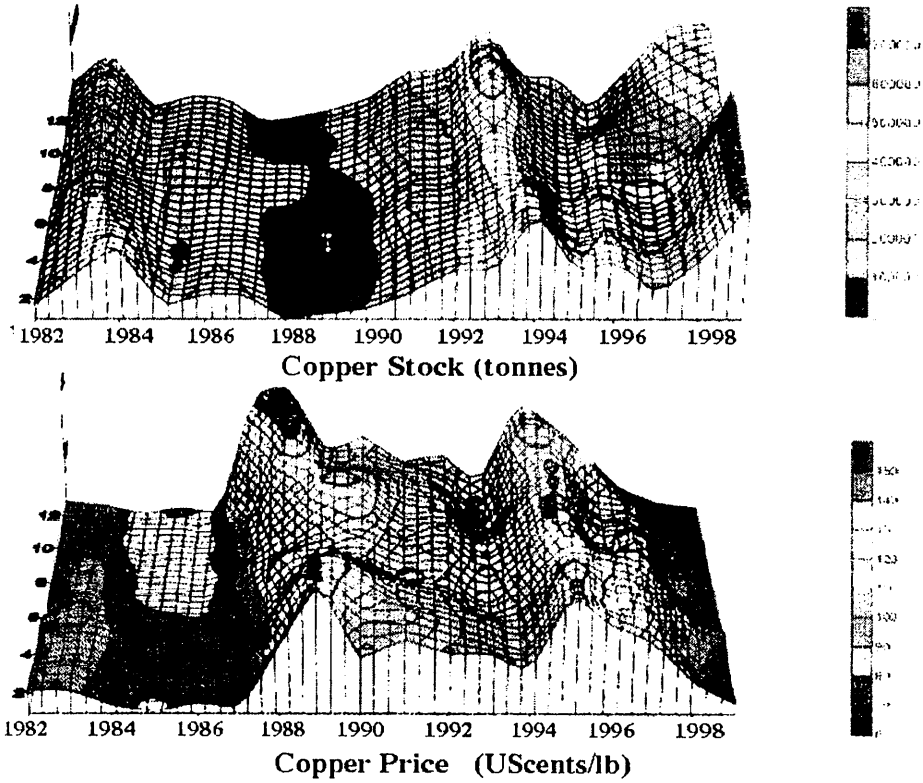

Fig. 3. Copper trends for the past two decades.
Source: *Venmyn Rand (Pty) Ltd.* Engineering & Mining Journal. 1998. Chicago.

The compelling need to reduce cost offers mining companies significant opportunities to build lasting value. Those organizations that succeed in reducing cost can emerge from the price war though stronger and better positioned than they may have been going into the downward cycle. Companies that get fit and get rid of assets that are not performing will find themselves in a stronger and better position to win in the future.

KGHM Polska Miedź SA copper complex have been achieving a 22% reduction of costs since 1996 but savings of this magnitude are possible for many other mining companies (the average world-wide cost is $0.65 per pound). Outcomes such as those given above offer an organization a great deal of flexibility. Efficiencies can be directed toward the bottom line or to dynamic increases in production capability.

At present the average prices of metals are going up. Prices of raw industrial materials stopped falling thanks to higher price rates of petroleum and metals. Analysts forecast that the prices of metals will grow next year (Economist Intelligence Unit). In comparison with the first term of 1999 metal prices increased 7. 8% in second term. In 2001 the copper market will be deficit, what will cause an increase of prices up to 100 cents per pound compared to 70 cents last year. For the main causes of this situation we can list:

- decreasing of production by major metal groups,
- reduction of a great number of new mining investments,
- fall in market stocks,
- economic growth, especially renewal of Asian countries economy and the good situation in the U.S. economy.

A decision-maker must consider which is the best choice between different mining projects. He has to compare different investments, different operation costs, different revenues etc. When the revenues are the same, it is not necessary to include them and it is enough to compare the total costs of the different alternatives. In such a case the variant with the lowest present capital value of all costs should be chosen or the alternative with the lowest total annual cost (operating costs plus annual capital costs). However in this instance we must remember that when comparing annual costs, the lifetimes must be the same.

Without including the revenues, it is not possible to calculate the internal rate of return. When the revenues are included, one should choose the alternative with:

- the shortest payback period,
- the highest net present capital value,
- the highest internal rate of return,
- the highest annual profit (the lifetimes of different mining projects must be the same).

We should avoid using one method only. All the methods must be compared and taken into consideration. Otherwise it can result in the wrong decision. A prudent decision-maker has to calculate the net present capital value, the internal rate of return and the annual profits for all alternatives before a decision is made.

A deposit is worth mining if the revenues per ton concentrate (or the ore) at the processing plant, are higher than mining and processing costs per ton. From time to time during analyses one should compare different types of equipment on a dollar per ton basis. When doing so, we must be sure that the tonnages used are right and are built upon real utilizations and not on theoretical capacities.

As has been mentioned in the first part of this paper, the uncertainty and risks involved with an investment in the mineral industry are higher than in most other industries. Examples of that are:

- lack of complete information about oregrades etc,
- high capital intensity,
- long development times,
- high variation in demand and prices,
- political risks,
- uncertainty about future taxes, inflation etc.

Even if a profitability study is very detailed nobody can be sure that something unexpected could happen that will change the estimated revenues, costs and profitability. A profitability study is therefore only a part of the material we have to consider in an investment decision. The profitability study must be supplemented by a lot of knowledge and experience gained from similar decisions earlier and analyses of what will happen if something in the profitability study is different than was thought at the beginning. The only thing we can be sure about is that the result of our investment decision will not be what we have thought.

5. CONCLUSIONS

In my paper I tried to show how important feasibility and profitability studies are in mining investment. At present the first Polish mineral project of cobalt-copper deposit in Congo has been suspended. Perhaps the result of this decision will be the loss of rights for exploitation. Before the start and during

the realization of the project we did not avoid mistakes. The main reason for bad reputation of these enterprises is starting a mineral project without given method of processing and metallurgy. After the start of exploitation it appeared that the geological data supplied by Gecamines consortium were false. In reality cobalt-copper ore contains considerably more oxygen compounds than sulphur. At that time KGHM did not possess the technology which allows getting metal from oxygen ores. The nearest smelting works able to process this deposit were found 200 kilometres from the place of production. At present KGHM has to pay $350 thousand per month to the owners of the mineral rights. In January 1997 KGHM bought (the price was $25 million) the right to produce 605 thousand tons of cobalt-copper ore. KGHM has to invest an additional $14 million to build a processing plant or it has to pay for breaking contracts now. Probably some faults in analysis has led to the present bad fortune in their first foreign mining investment. If the analyses had been done correctly this investment might have ended with success. In spite of its failure KGHM has to seek new deposits, to buy them, to build mines and process plants and first of all to learn the arts of investing outside Poland. The only way is practice. In Congo it was the first sad lesson and I hope the last.

It is hard to give a procedure of how to perform a study, which can be used in all cases. This is because all deposits look different, each mine is unique, etc. But the procedure as mentioned above can be a guideline on how to work, especially if one wants to open a new mine.

Performing all these studies will increase the understanding among decision-makers that we are working in a changing world not knowing what will happen in the future and the result of an investment decision is uncertain. However we should identify the possible risks, the possible outcomes and estimate the probability for different outcomes. By combining the different outcomes and the probability for each outcome, we can estimate the chance of achieving a given level of profitability for a specific project. This will not give the decision-maker a final answer of what to do, but it will increase his knowledge and understanding of the complex problem.

The board of directors of a mining company, lenders and project sponsors confront many risks when developing a new mining project. Therefore they should analyse feasibility and profitability studies carefully to make the mining industry as rewarding for all of us as the circumstances allow.

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